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Evaluating Occupant Load Factors for Business Operations

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An Interactive Qualifying Project report completed as required of the Bachelor of Science degree at Worcester Polytechnic Institute

Submitted to the Faculty of Worcester Polytechnic Institute

By

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Professor Milosh Puchovsky, M.S., Project Advisor

Evaluating Occupant Load Factors for Business Operations

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Acronym Reference Table

Acronym	Meaning
ASF	Assignable Square Feet
BOMA	Building Owners and Managers Association
GFA	Gross Floor Area
GSA	Gross Square Area
FDISG	First Data Investment Services Group
FPRF	Fire Protection Research Foundation
ISU	Idaho State University
NBS	National Bureau of Standards
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
UN	United Nations

Signature Page

This page is to signify that each group member agrees with the submitted reports by signing his respective name to this page.

Group Member	Electronic Signature
Tom Thackeray	Thomas C. Thackeray
Tudor Muha	
Tyler Wood	

Acknowledgements and Allocation of Writings

Group Member	Contribution to Final Project
Thomas Thackeray	Put together final project and wrote: key terms, What is Occupant Load Factor, Breaking up Business Occupant Load, Why we chose these different categories, Open Space Planning, Questionnaire section and why we sent questionnaires to the three different groups. Sent Questionnaires to Real Estate Agents
Tudor Muha	Wrote Methodology of Project, Calculated and collected the information needed for our results section, The reason of existence of business occupant load, Future trends, Results and the Discussion. Sent Questionnaires to Architects
Tyler Wood	Wrote Past Studies Section Sent Questionnaires to Building Owners

Collaboration Work

Tom and Tudor collaborated to put together the abstract and Tudor and Tyler collaborated to put together the introduction and discussion sections. All three of us collaborated to put together the conclusions section.

Key Terms

Occupant Load: "The occupant load of a building is the total number of persons that might occupy a building or portion there of. Occupant load requirements from the Life Safety Code vary based upon the type of occupancy" (ehs.gatech.edu).

Business Occupancies: Occupancy used for the transaction of business other than mercantile. "Occupant load is determined by one person per 100 square feet of gross floor area" (ehs.gatech.edu).

Gross Floor Area: "Sum of the floor areas of the spaces within the building" (gbci.org).

Occupant Load Factor: The occupant load factor is a designation of square feet per person based upon the use of a given space. It is used to determine occupant load by dividing the occupant load factor from the overall square footage of an area.

Partitioned Office Spaces: A partitioned office space consists of an interior, wall or screen which separates offices from one another.

Teleworking: "Telework occurs when information and communications technologies (ICTs) are applied to enable work to be done at a distance from the place where the work results are needed or where the work would conventionally have been done" (eto.org.uk).

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Executive Summary

The current NFPA occupant load standard for business use areas is 100 square feet per person. This standard was originally created in 1934 Building Exits Code based upon several studies conducted and then strictly analyzed. This 100 square foot standard was based on office, factory and workroom gross floor area, not taking into account any area which was reserved for corridors, closets, restrooms or other similar type areas (James A. Milke). There have been six significant studies conducted within the business occupant load field since that original 1934 Building Exits Code study was completed. The six studies are John H. Courtney and Harry B. Houghton, seen in Appendix A, associate engineers at the Bureau of Standards (1934), BOMA (1966), Nelson (1969), Johnson and Pauls (1977), Cormier, De Wolf, Henning, and Schneider for Public Works Canada (1977), and Bourdeau (1992) (James A. Milke). Below are the following business use averages for each study.

Survey Team	Occupant Load Factor (ft^2/person)(gross)
NBS	87
Nelson	150
BOMA	160-275
Johnson and Pauls	243-278
Cormier, et al.	220-230
Bourdeau	175-200

Figure 1: NIST Milke Study

As shown above, each study since the BOMA study in 1966 has held a much higher business use occupant load average than the standard 100 ft^2.

In the 21st century businesses and building owners have taken a different approach in tackling the occupant use problem. The power-point the United Nations published in January 2008 is a great example of what many companies are starting to do. The United Nations decided to break up their office spaces into four different uses which can be seen below.

New Office Space Plan:
Workstyle A – USG/ASG, Enclosed Area (384 square feet)
Workstyle B – Directors, Enclosed Area (192 square feet)
Workstyle C – Professionals, Open Area (96 square feet)
Workstyle D – General Services, Open Area (64 square feet)

Instead of simply using one standard for their business occupant load the United Nations broke up the uses into four different categories to best utilize their given space. Today's buildings are much more diverse than buildings in the past and they must be treated as such.

As a group, we believe that the United Nations has the correct approach when it comes to space planning. Our group has suggested five different groups be used to categorize the business occupant load group. These five categories are:

- Private offices with closed floor to ceiling partitions (260 square feet)
- Open plan spaces with seating with opened floor to ceiling partitions (145 square feet)
- Open plan spaces with limited or no seating with or without semi partitions (150 square feet)
- Laboratory function spaces either wet or dry type (364 square feet)
- Public access spaces such as entrance lobbies, waiting areas, etc. (72 square feet)

Business occupant load should be broken down into these five categories to better serve the people currently following the previously lone standard of 100 square feet. Breaking this broad category into five options, all of which hold their own, well suited occupant load standard, allows for a much more efficient use of floor area. As a group we believe, breaking this category into four sub-categories, is the best option available. However, if breaking the current business occupant load category into five sub-categories is not an option then we propose that the current business occupant load be raised from 100 square feet to a more liberal number. This new business occupant load number should be double the current business occupant load, making the new business occupant load 200 square feet per person.

Abstract

The objective of this research is to provide data to the Technical Committee on Mercantile and Business Occupancies (BLD/SAF-MER) to either support the current occupant load factor of 100 sq. ft. or to justify the need for multiple occupant load factors for business use areas. Also, the project will answer whether a new singular business occupant load standard is needed and/or how the current business occupant load should be categorized and why such categories within the general business occupant load category are needed.

Introduction

The minimum occupant load is defined by section 7.3.1.2 of the *Life Safety Code* (NFPA 101). For "business use" areas, the occupant load factor shall not be less than 100 square feet per person. This is based on gross floor area, which is defined as "the floor area within the inside perimeter of the outside walls of the building under consideration with no deductions for hallways, stairs, closets, thickness of interior walls, columns, or other features" (NFPA, 2003a). The occupant load factor was first mentioned in the Building Exits Code in the 3rd edition published in 1934. It specified 100 square feet per person for office, factory, and workroom uses. The purpose of the adoption of occupancy load was to change the method of assessment of egress design. There is no formal record in existence explaining the basis of 100 square foot per person being included in the Building Exits Code of 1934. This presents the question, is the current occupant load factor, as specified by NFPA 101 and NFPA 5000, for business use areas adequate for all types of business uses that we see today? Some business uses, such as call centers or high productivity, technology based businesses, may be arranged so as to contain a higher density of occupants within the space than would normally be found in a traditional office layout. This generates the question if the current occupant load factor of 100 square feet is appropriate for all business uses, and if not, is there a need for multiple business use occupant load factors to accurately calculate occupant loads for business use areas with alternative densities of occupants?

Background

There is a need to evaluate the validity of the current occupant load factor of 100 square feet per person for a variety of business use areas. During their ROP, the TC on Mercantile and Business Occupancies voted to change the occupant load from the current 100 square feet per person to 150 square feet per person, based upon technical substantiation that was provided. At their ROC, the TC voted to change the occupant load back to 100 square feet per person based upon several comments that were received and the committee's need to more documentation and justification. The committee was in agreement that this is an issue they must address in the future, but was not able to determine the correct action during this cycle due to the lack of technical support for the issue.

This project best lends itself to a literature review as well as a field study. There are published studies completed on this topic in the past. The literature review should carefully review these works and their applicability to today's business use spaces. For the field study, a variety of business use areas should be evaluated including those that may contain a variety of densities of occupants such as a call center, a traditional office layout, and other business use areas as needed. The study should include data samples that are geographically diverse as well as diverse in size, function, demographics, and ownership (example: government buildings versus privately owned office buildings).

What is Occupant Load Factor?

"The occupant load of a building is the total number of persons that might occupy a building or portion there of". The current business occupant load factor is 100 ft^2 per person. This current occupant load pertains to all different types of businesses, from call centers to laboratories to law offices, it does not matter what type of business it is because 100 ft^2 per person is required for all. The occupant load factor effects buildingsafety factors such as the number of exits, proximity of those exits, and the overall safety of building stairwells to go along with the occupant load but we, as a group, will only focus on the validity of the current business occupant load. The current 100 ft^2 per person business occupant load is based on the

studies conducted for the 1934 Building Exits Code and as a group we are trying to find out if this guideline is still relevant today, over seventy-five years later(James A. Milke). Our IQP team will look into and through educated research and studies will propose whether the business occupant load factor should stay the same, change altogether or break into different categories with separate occupant loads to help better define the term business occupant load.

Past Studies

In order to investigate the aptness of this 80 year old Occupant Load Factor, we looked at past studies on the matter.

Two engineers of the National Bureau of Standards, John H. Courtney and Harry B. Houghton, conducted the first study of occupancy load in 1934; analyzing the design and construction of building exits in buildings of various occupancy types. A total of 22 office buildings were surveyed in Atlanta, GA, Greenville, SC, Greensboro, NC, Roanoke, VA, Washington, DC, Frederick and Baltimore, MD, and Pittsburgh, PA. It was conducted through building walkthroughs to find the number of building occupants in factories, schools, and offices, as well as surveying building owners. Their findings concluded a range from 66 to 160 square feet per person, with an average of 87.2 square feet per person. It is likely that most offices included in the survey were compartmented, as open-plan offices were rarely found in the 1930s. The study remained unpublished until 1935, yet 100 square feet per person appeared in the Building Exits Code of 1934(James A. Milke). As previously stated, there is no formal record in existence connecting the NBS study with the occupancy load factor adoption in the Building Exits Code, but its acceptance appears to be based on its relative simplicity for purposes of designing egress and fire suppression systems around the number.

The next study was conducted about 30 years later in 1966 by the Building Owners and Managers Association (BOMA). It was a national survey distributed to building managers that has been repeated annually to this day, and its results are published each year in the BOMA “Experience Exchange Reports”. Results from approximately 1,000 responses concluded an average occupancy load of 160 square feet per person. A relatively steady increase from this

number was noted up until 1986, when it stabilized until 1990 at approximately 275 square feet per person (James A. Milke).

In 1969, Harold E. Nelson conducted a study on the space utilization of federal government office buildings in Philadelphia, PA and Washington, DC. The space planning data compiled in the study yielded an average occupant load of approximately 150 square feet per person (James A. Milke).

In 1977, B.M. Johnson and Jake Pauls assessed the videotape records of evacuation drills in Canadian office buildings. An average occupancy load factor of 243 square feet per person was found (James A. Milke).

A study conducted by Cormier, De Wolf, Henning, and Schneider for Public Works Canada found the area of standard office workstations to be 175 to 185 square feet per person. In order to find the gross floor area from the workstation data, they used a conversion factor of 1.25 to find an occupant load factor of 220 to 230 square feet per person (James A. Milke).

M.A. Bourdeau conducted a walk through survey of buildings at the College Park Campus of the University of Maryland in 1992. He surveyed 18 floor levels in eight office buildings and found a range of occupant load factors from 175 to 200 square feet per person (James A. Milke).

Each of these studies used different methods of data collection and sample groups. The result from the five studies since 1935 shows a range from 150 to 278 square feet per person (James A. Milke). These results are dramatically different from the findings in the NBS study of 1934 at an average of 87.2 square feet per person, suggesting the evolution of office design over the years has changed overall occupancy loading of business use areas. The most informative study is the BOMA survey given it is repeated annually with a large sample group and shows an increasing trend in Occupancy Load in Business Use areas.

Methodology

For this project the team was comprised of 3 members: Thomas Thackeray, Tyler Wood, Tudor Muha, all WPI students. The project represented their Interactive Qualifying Project (IQP), required by their curriculum. The advising professor was Professor Milosh Puchovsky from the Department of Fire Protection Engineering. The group also had an advisory board with members from NFPA, GSA, NIST, FPRF and other interested institutions, who guide the group and helped it with background, contacts etc. All the members are listed below:

- Amanda Kimball, FPRF
- Ken Bush, Maryland State Fire Marshal's Office
- Kristin Collette, NFPA Staff Liaison
- Josh Elvove, GSA
- Dave Frable, GSA
- Nancy Hurley, NFPA
- Erica Kuligowski, NIST
- Dan O'Connor, Aon Fire Protection Engineering Corp.
- John Tello, Boston Properties

The project started on August 23rd 2011, the deadline being on the 2nd of March 2012, by this date the team was supposed to provide prof. Puchovsky with a paper in which they discuss their findings.

The team met with the advising professor every week for at least one hour, in which they would present what they have done so far and make propositions and conclude on what they have to do until the next meeting. The team also had conference calls with the advisory board.

The first step that the team took was to make the schedule of the project, explaining what they will do step by step until the deadline; the major steps are presented below:

1. A term (23rd Aug. - 16th Oct.)
    a. Find what does the occupant load factor mean in present times, how it is calculated and used in designing of office space environments;

b. Research when, why and in what conditions did the occupant load factor came to existence;
c. Talk to people which could provide further information about the origins of the occupant load factor;
d. Search for previous proposals of changing the factor and find out what they proposed, why they proposed it and why did they fail in changing it;
e. Establish a plan of evaluating the present usage and the future demands of the occupant load factor from people who are influenced by it.

2. B term (16th Oct. – 18th Dec)
    a. Study how office buildings are designed and used;
    b. Come up with a list of people which the group can interview to see what they think of a change in the occupant load factor and what this change should be;
    c. Establish what groups of people are influenced by the occupant load factor, that may have something to say about changing it;
    d. Build questioners specific to every group identified above, and try to gather as much information possible about the needs of these groups regarding occupancy load.
3. C term (12th Jan. '12-2nd March '12)
    a. Send the questioner out to the groups of people found in the previous term;
    b. Investigate other sources in which an occupant load factor may be found (i.e. space planning guides)
    c. Group all the information gathered so far from all the resources;
    d. Analyze the information and conclude if the occupant load should change and what its value should be.

These were the major steps, from our schedule, that the team took in order to complete this project.

The literature research, especially the one until the year 2000, proved to be very hard to do because not many papers were concerned with this matter, others were just lost, but a

great deal of help was provided by the advisory board in giving the team, contacts of people who might know more about the reason of existence of the occupant load factor and most important the basis of it being 100 square feet per person.

The team divided among themselves the places in which they most likely were to find anything on the occupant load factor, these were:

- Local and national libraries (Gordon C. library from WPI, NFPA library, Worcester Public Library etc.);
- The World Wide Web (this included also a very helpful tool that Google has, named N-gram Viewer, which has 12 million books scanned (Wikipedia, 2012) and present the user with the ability of searching for words, phrases in all of these books).
- People that have knowledge about the existence and evolution of the occupant load factor.

The next step that the team took was to analyze what is the present use and value of the occupant load factor. For this the team had to interview as many people possible, for this purpose the team investigated the potential focus groups coming with 3 main categories:

- Real estate people.
- Building owners/managers.
- Architects.

The questionnaires were specifically developed for the group of people that they would be sent to. The team tried to cover as much of the United States as possible coming up with contacts (e-mails) mainly from the West and East Coast. The team also contacted BOMA (Building Owners and Managers Association) which its North American membership represents a combined total of more than nine billion square feet (850 million m2) of downtown and suburban commercial properties and facilities from its 165000-plus members (BOMA International).

The next step that the team took was to analyze the space planning guide which included books, online references and companies which had their main business focused on this. Of course that these references did not present a specific occupant load factor, but presented office plans layouts from which the team could estimate an occupant load factor that the plans implied.

Literature Review

This is a comprehensive study reviewing both past and present studies within the business occupant load, open office space plan and future trends of office spaces fields. In this review we will explain our reasons for why a multiple category business occupant load is needed and the studies supporting these statements. Also, we reviewed our questionnaires which were sent out to architects, building owners and real estate agents. This section will explain tools we used to build our questionnaires

Reason of existence (why was it calculated)

As we can see from a couple of publications before the 1934 Life safety Code, the reason for this limitation in design of buildings came from the concern of insurance companies who wanted to know how much to charge the building's owners. They came up with a fire insurance rating, that rated buildings based on hazard and occupancy. The concern was that as a business in a building changed, based on the type of business the number of people and the type of machines used could change dramatically, by that we mean that if the machines were considered hazardous and there were more people operating these machines then as a result more accidence could happen, more accidence results in a higher probability of fire which could mean high capital loss.

The Encyclopedia Americana: a library of universal knowledge, Volume 11 in 1919 Page252:

"Limitation of Occupancy Private Enterprise and public regulation necessarily go hand in hand in the repression of unnecessary fire loss. The preceding paragraph has referred to buildings designed for a particular occupancy but through economic changes buildings are often diverted from their original purposes and the character of occupancy entirely changed In order to guard against possible unfortunate results from such changes careful municipal regulation is necessary. While great restriction is obviously impossible some limitation of the number and character of tenants is absolutely requisite to avoid at least partial nullification of original designs."

Even at that time things were evolving rapidly as we can see from the book “Insurance and Real estate” by Edward Rochie Hardy, Walter Lindner in 1913.

“Formerly the business building was usually 25 by 100 feet and 5,000 square feet was an extraordinarily large property. Nowadays the area may be 100,000 square feet and the problem of how to meet the new condition becomes far more intricate than the mere increase in area would imply.”

After reading this, it was evident that the need of a code was in high demand.

Breaking up the Business Occupant Load into multiple sub-categories

Our interactive qualifying project team believes that there should be five different categories of Business Occupancy. Currently there is only one category for Business Occupancy Use which is not nearly specific enough to encompass all the needs of various businesses. In the 2009 International Business Code there is all the different functions of space along with their occupant load. For categories such as Institutional areas there are three sub-categories. These sub-categories are inpatient treatment areas, outpatient areas and sleeping areas. Each of these categories make-up the variety of uses found in an institutional area. Many of the other function spaces are also broken into sub-categories just as our one, specific example was. This led our group to believe that there could be an effective, sensible way to break up the business occupant load category into sub-categories as well. We decided to break up the business areas function space into five different sub-categories. These groupings specifically sub-categorize the many different types of business areas while still being broad enough to fit each possible business use into one of these five sub-categories. Our proposed sub-categories within the business area function of space are:

1) Partitioned (floor-ceiling) Office Spaces, i.e. Private Office.
    a) Director's Office/ Physician Office
    b) Private Office

Idaho State University defines an office as “a space housing faculty, staff, or students working at one or more desks, tables, or workstations”. They also state that their office facilities “are individual, multi-person, or workstation spaces specifically assigned to executive, academic, administrative, and service functions of Idaho State University”. Below is the design standard Idaho State University laid out for office space.

Design Standards for Office Space Types:

Office Facilities (310)	NASF
Dean and Equivalent	200 Min.
Chairs, Directors, Dept. Head and Equivalent	150 Min.
Faculty/Professional/Sr. Staff and Equivalent	120 Min.
Student Assistants	100 (See Note #3)
Administrative Assistant, Office Specialist, Secretarial, Clerical	100
Staff and Others	80
Cubicles	50

In Appendix B, example programs of “Fully” closed office spaces are given by the Whole Building Design Guide (WBDG).

2) Open Plan – no seating
    a) Printer Areas, Copy Machines
    b) Mail Rooms
    c) Radio Station
    d) Television Station

3) Open Area Plan (seating provided)
    a) Call Centers
    b) Cubicle – (not floor to ceiling height)
    c) Control Rooms
    d) Computer terminals
    e) Open work space
    f) Electronic data processing

In Appendix C, example programs of “Fully” open office spaces are given by the Whole Building Design Guide (WBDG).

4) Laboratory Spaces
    a) Classroom Laboratories
    b) Open Laboratories
    c) Research Laboratories
    d) Medical Laboratories
    e) Computer Laboratories

Idaho State University space planning guidelines describes a laboratory as “a facility characterized by special purpose equipment or a specific space configuration that limits instructional or research activities to a particular discipline or a closely related group of disciplines. These activities may be individual or group in nature, with or without supervision. Laboratories may be found in all fields of study including letters, humanities, natural sciences, social sciences, vocational and technical disciplines, etc” (isu.edu). Idaho State explains that there is three different categories in which laboratories can be divided into, class open and research laboratories. Shown in Appendix A is Idaho State Universities ASF (assignable square feet) per Station Planning Guidelines.

Class Laboratory: “A space used primarily for formally or regularly scheduled instruction (including associated mandatory, but non-credit-earning laboratories) that require special purpose equipment or a specific space configuration for student participation, experimentation, observation, or practice in an academic discipline. A space is considered to be scheduled if the activities generate weekly student contact hours (WSCHs), the activities fulfill course requirements, and/or there is a formal convener present” (isu.edu).

Open Laboratory: “A laboratory used primarily for individual or group instruction that is informally scheduled, unscheduled, or open” (isu.edu).

Research Laboratory: “A space that directly serves one or more research/non-class laboratories as an extension of the activities in those spaces” (isu.edu).

5) Public Access Spaces
    a) Entrance Lobbies
    b) Waiting Areas

Why We Chose these Five Categories

The reason we chose these different categories to describe business occupant load is because they successfully break up the broad category of business into five different, encompassing categories. These proposed categories separate the major groupings within the business occupant load yet each grouping is just broad enough to cover a number of different businesses for each category. All businesses can successfully be described as fitting into one of these five categories. It is important, that if we break up business occupant load into different categories, that each business, in today's world or in the future, can positively be group into the right category as well as the group business occupant load number. The hardest part we will face after we decide on the different groups falling under business occupant load will be the following feet per person standard pertaining to each group. We will be able to find numbers for each of the different groups through past research as well as through research and surveys of our own. It is important that these categories encompass a large enough region where as any new, upcoming business has a category in which it may fall under.

What is Open Space Planning

Open space planning has become a major concern of business and building managers in recent decades. Successfully creating an open, welcoming environment turns out to be extremely effective in increasing worker production and morale. The New York State Office of General Services describes in great detail what exactly open space environments entail. It is stated that "open space office environments embrace the concept of ergonomic design by using furniture systems to maximize work efficiency and employee comfort. Open office planning was developed as a means of providing organizational flexibility, promoting interactions among people in different units, and supporting a team concept. An open office significantly reduces the number of private offices and distributes staff throughout the space in workstation groups. Offices and conference rooms are situated in the center of the floor to allow the staff to work by perimeter windows to access natural light. In addition, the furniture systems use lower panel heights to improve lighting and the circulation of heat and air conditioning" (New York State Office of General Services). Open space offices enhance the aesthetics of the given building and economize the space of the floor area within the building. As we see how important open space planning is this could heavily affect the current business occupant load standard that is currently in place. The current number is 100 sq. ft. per person and if this number is lowered from its current place it will allow space planning managers to open up the given work space more than currently given which will lead to a better, more efficient work place.

Open Space Planning Allocation Standards

While researching the business occupant load standard our group has noticed that many of the standards for different uses have multiple standards within the different categories. However, the business occupant load standard has only one number at 100 sq. ft. per person and this standard encompasses a number of different uses that are fundamentally different. Below, I have added open space standards as show by the United Nations and University of Virginia.

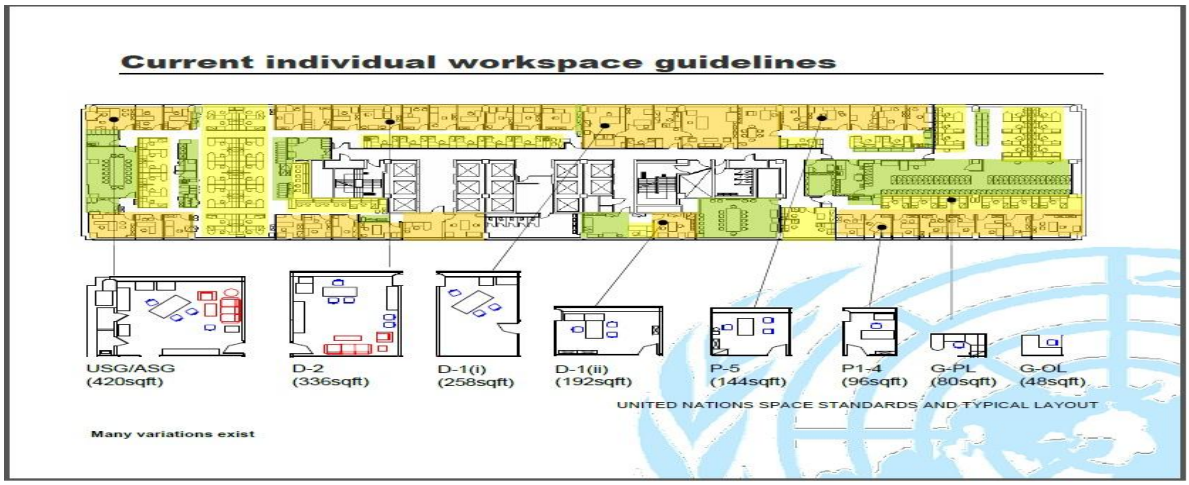


Figure 2: Current individual workplace guidelines (January 2008)
Note: This figure was adapted from the United Nations Space Standards and Typical Layout
http://www.un.org/cmp/uncmp/docs/Office%20Space%20Planning%20Guidelines%20Jan08_iSeek%20_FINAL.pdf

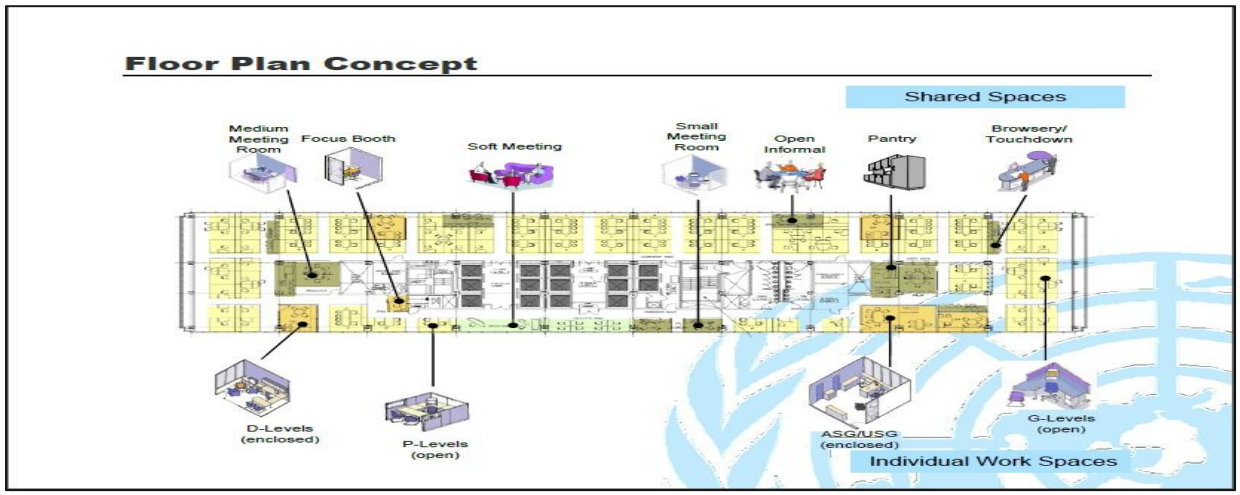


Figure 3: Floor Plan Concept (January 2008)
Note: This figure was adapted from the United Nations Space Standards and Typical Layout
http://www.un.org/cmp/uncmp/docs/Office%20Space%20Planning%20Guidelines%20Jan08_iSeek%20_FINAL.pdf

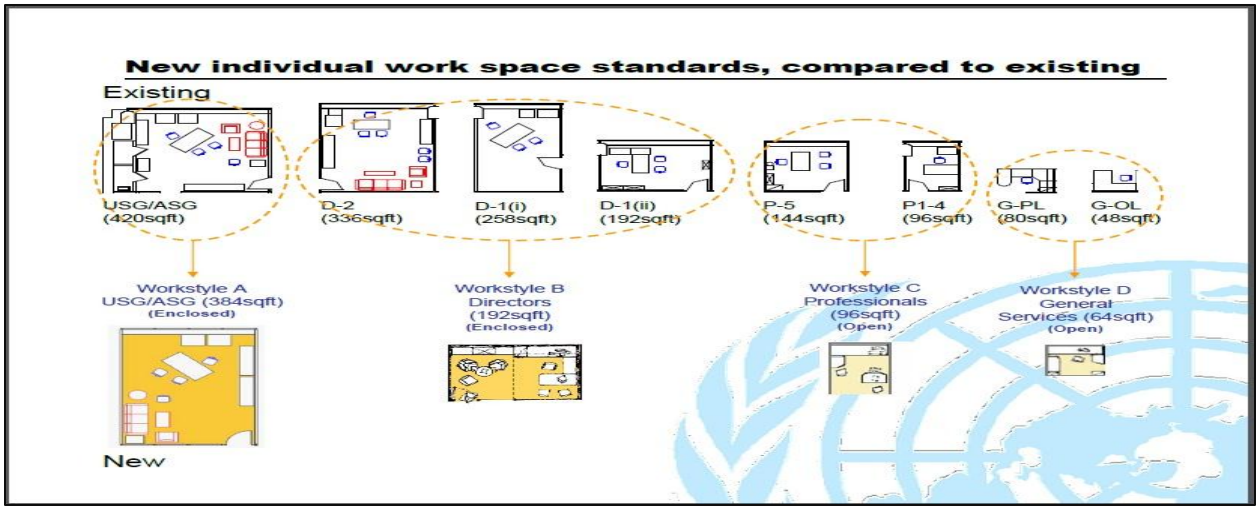


Figure 4: New individual work space standards, compared to existing (January 2008)
Note: This figure was adapted from the United Nations Space Standards and Typical Layout
http://www.un.org/cmp/uncmp/docs/Office%20Space%20Planning%20Guidelines%20Jan08_iSeek%20_FINAL.pdf

As you can see from these figures the United Nations wants to differentiate their space standards into multiple different categories. As a group we feel this is the strongest option available because it allows the current standard to still be effective but also fits better standards to different type of business uses to better serve these uses. By breaking up the current business use into multiple categories we allow more accurate standards to take precedence. The current University of Virginia standards can be found in Appendix A. The state of Washington's, General Administration's *Space Allocation Standards Manual*, published December 29th, 2009, has multiple examples of what different workstations should look like and these examples can be found in appendixes G, H, I, J, K, L, M, N, O, P.

Examples of Open Space Planning

United Nation Space Planning Guidelines:

Back in January, 2008 the United Nations published a power-point displaying their extensive restructuring of closed and open office space planning. In their current office space layout they implemented over eight different kinds of workspaces and one of their key restructuring points was to simplify their workspace choices. The UN came up with four workspace types they would use in the future and decided that the workspace square footage would be in multiples of each other, creating easy configuration (United Nations). Their four workspace types would be, small meeting rooms (typically 2 per floor at 96 sq. ft.), open informal (typically 1 per floor at 64 sq. ft.), medium meeting room (typically 2 per floor at 192 sq. ft.), and soft meeting (typically 1 per floor at 64 sq. ft.) (United Nations). Below is the current office space plan and the different workspaces along with the new office space plan and the respective workspaces:

Current Office Space Plan:
Workstyle A – USG/ASG, Enclosed Area (420 square feet)
Workstyle B – Directors, Enclosed Area (336, 258, 192 square feet)
Workstyle C – Professionals, Open Area (144, 96 square feet)
Workstyle D – General Services, Open Area (80, 48 square feet)

New Office Space Plan:
Workstyle A – USG/ASG, Enclosed Area (384 square feet)
Workstyle B – Directors, Enclosed Area (192 square feet)
Workstyle C – Professionals, Open Area (96 square feet)
Workstyle D – General Services, Open Area (64 square feet)

The new office space plan creates maximum open space, lighting and outside views within the building. The proposed layout offers 80% open office areas compared to just 34% open office areas previously offered (United Nations). The UN streamlined their office space planning to really maximize the floor area available to them.

Office Space Planning: Designing for Tomorrow's Workplace:

In Mcgraw-Hill's Professional Architecture Office Space Planning book there are multiples case studies describing the change in today's workplace. The first case study I reviewed was a local company located in Westborough, Massachusetts named First Data Investment Services Group. The project was completed in 1996, the building area is 300,000 ft^2 with 1,600 people within the building. Their mission was to "maximize efficiency, flexibility, and access to information" along with enhancing corporate culture and client perception of FDISG. The designers were able to complete these goals by creating four different workstations. The four workstations they created were call centers (36 ft^2), financial services (48 ft^2), administrative staff (64 ft^2) and Managers (96 ft^2).

Another case study detailed within this book's confines is the office space planning of accounting firm, Arthur Anderson. The company, located in Boston, Massachusetts, held a 108,000 ft^2 building area, holding 700 people. Their building felt tightly packed and poorly arranged. To fix this, once the firm decided to move to an open space planning arrangement they had three different categories of offices. Private offices were to be designed at 130 ft^2, open workstation for those often in their office were 48 ft^2 and open workstations for those who were in their office little were 36 ft^2. They also believed that their offices should be broken up into multiple categories.

Future Trends in the Office Place

The bullet-points and figures below illustrate GSA's Leveraging Mobility, Managing Place pdf document. This document explains the growing shift in employees who work from home. Not only does this shift save a massive amount of emissions as shown in the tables below but it also greatly affects the current layout of most office buildings. The explanation of an ever evolving workplace can be seen and described below.

Basic Telework:

- "The Basic Telework scenario is an expansion of current practices. It assumes that 15 percent of employees are working from home 2 days per week, but the agency has made no change in real estate or workplace strategy" (GSA).
- "In the Basic Telework scenario, the agency's space is unchanged from the Baseline scenario" (GSA).
- "Individual workstations are assigned to all employees, including mobile workers" (GSA).
- "Compared to the Baseline, the environmental impact of this scenario is a slight reduction in GHG emissions from employee commute and no reduction in emissions from building operations" (GSA). In the figure below you can see why more and more companies are having their employees work from home.

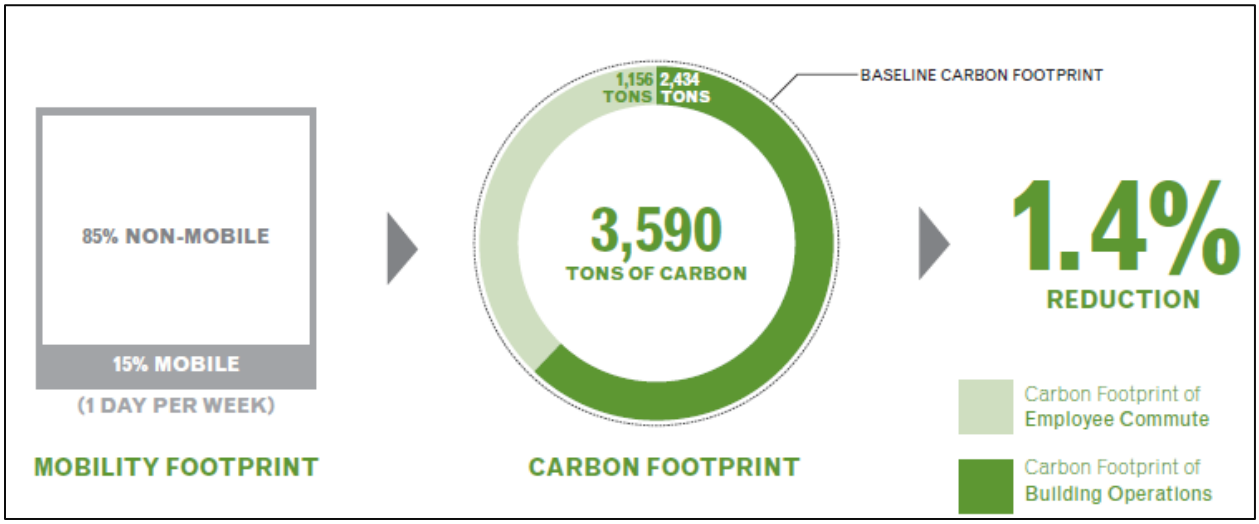


Figure 5: Basic Telework, Adapted from GSA's Leveraging Mobility, Managing Place
http://archive.teleworkexchange.com/pdfs/Leveraging_Mobility.pdf

Responding to Mobility:

- "This scenario illustrates the impact of redesigning the workplace to respond to a workforce where 80 percent of employees work at home or another off-site location 2 days per week and are internally mobile while working at the office" (GSA).
- "Each employee has an assigned workstation that is smaller and more densely organized than workstations in the Baseline and Basic Telework scenarios" (GSA).
- "The overall real estate footprint remains unchanged; however, space is allocated differently" (GSA).
- "This scenario provides a significant reduction in GHG emissions from employee commute over the Baseline, but no reduction in emissions from building operations" (GSA). This scenario can be seen in the figure below.

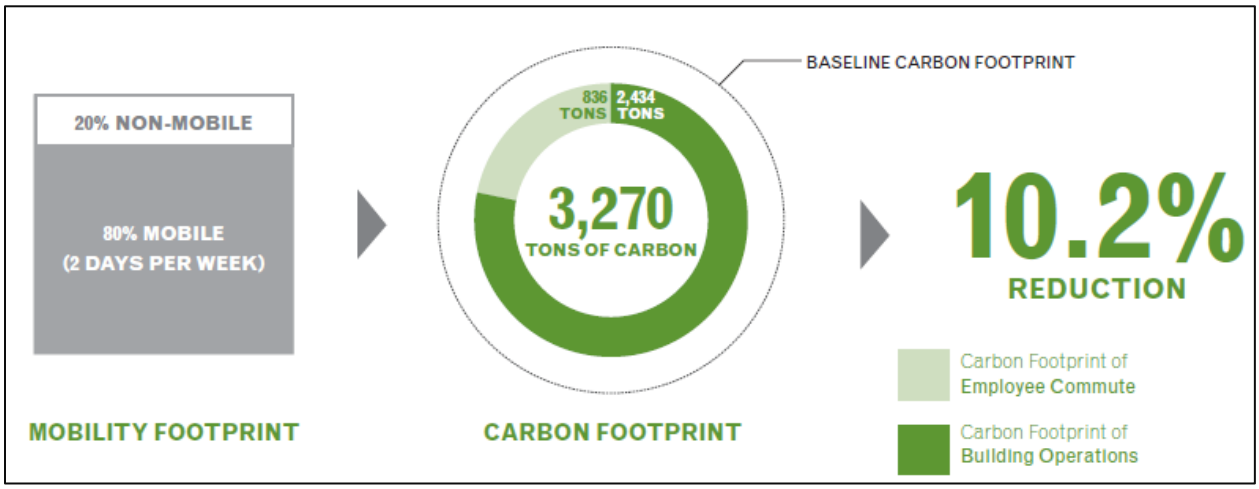


Figure 6: Responding to Mobility, Adapted from GSA's Leveraging Mobility, Managing Place
http://archive.teleworkexchange.com/pdfs/Leveraging_Mobility.pdf

A mobility program offers an agency the opportunity for much better space utilization by replacing dedicated workstations with open workstations that employees use only on the days they are in the office. Utilizing this strategy, the USPTO telework program, for example, reported in 2009 that their 9,643 employees currently occupy a space that would accommodate about 5,000 traditional, or non-teleworking, employees.

As a conclusion we can say that we expect the occupant load factor to increase as time goes by, the reason being that as more people are teleworking, less people will remain in the office area which means that there will be more square feet assigned per person.

Questionnaires

Our Interdisciplinary qualifying project team decided that the most effective technique for us to collect a substantial amount of information was to create a detailed yet efficient and quickly completed questionnaire. Quickmba.com lists eight steps that are very important to follow while trying to create a questionnaire to send out, these eight steps are listed below:

- "Determine which information is being sought.
- Choose a question type (structure and amount of disguise) and method of administration (for example, written form, email or web form, telephone interview, verbal interview).
- Determine the general question content needed to obtain the desired information.
- Determine the form of response.
- Choose the exact question wording.
- Arrange the questions into an effective sequence.
- Specify the physical characteristics of the questionnaire (paper type, number of questions per page, etc.)
- Test the questionnaire and revise it as needed."

As a group, along with our advisor, Professor Puchovsky, we decided what information we wanted to retrieve from the questionnaire along with how to make the questionnaire as concise as possible. Within this questionnaire we wanted to get as much solid results as we could while still making the questionnaires quick and easy to complete which we determined to be a questionnaire that would take less than five minutes. The three questionnaires, Real estate, Architect, and Building owner questionnaires, are shown in Attachment L,M,N respectively. Each of these three questionnaires was sent out to our respective contact lists and the information we received was pooled into an architect, real estate agent and building owner category on the survey website, SurveyMonkey.com.

Why send questionnaires to Real Estate Firms, Architects and Building Owners

Real Estate Firms:

As a group we knew that it would be crucial to get solid information regarding business occupant uses to move forward in our project. Our problem was deciding who exactly was important to ask when retrieving information because the business occupant load encompasses a very large spectrum of business uses. However, a good indication of why Real Estate firms and agents were a strong choice is the Flannery Associates, *Introduction to Fire Science*, business section where it states, business occupant uses hold "occupants more familiar with [the] area, but they may have confusing layouts" (Flannery Associates). Successful real estate agents and firms must know the detailed information of the buildings they are dealing with and what their clients are looking for. We concluded that because the real estate agents would know the ins and outs of each building they sold or were trying to sell that they would be a very important group of people to survey while collecting information for this project. Below are all the different real estate firms that we contacted.

- Hammond Residential, http://www.hammondre.com/
- R.J. Greely Co., LCC, http://www.rjgco.com/
- Brown & Wagner, LCC, http://www.brownwagner.com/contact/contactusform.htm
- Colliers International, http://www.colliers.com/Markets/Boston/
- Bancroft Commons, http://www.bancroftcommons.com/leasingOffice.htm
- Cutler Management, http://cutlermanagement.com/
- Central Mass Realty, http://www.centralmassrealty.com/
- Foster-Healey Real Estate, Inc., http://www.foster-healey.com/

Architects:

Architects were the group of businessmen who we believed would have the greatest understanding of what the business occupant load was exactly. The architects are the men and

women who design the buildings which encompass our discussed business use areas. We thought that sending out questionnaires and receiving information from established architects would add greatly to our team's results. However they responded to our questions, whether they believed the business occupant load should stay at 100 square feet or that it should be changed would weigh heavily in our final suggestions regarding the occupant load.

Building Owners:

When deciding what groups of people we should send questionnaires to building owners were an obvious choice. Building owners would know exactly how they would want their floor area allocated and whether or not the current business occupant load was appropriate. Also, we believed that building owners would have the best understanding in whether or not there should be multiple categories within the general business occupant load category. This is because unlike architects, building owners are more concerned with the business taking place in their building and what type of business uses are necessary for each respect business.

Results

When collecting research for our final conclusions for this project we recalled information from not only our own personal questionnaires, which we sent out but from over seventy surveys of office buildings. Below there are five different graphs showing the change in public spaces, laboratories, open plan spaces with seats, private offices and open plan spaces without seats occupant loads over time. As you can see, every graph besides private offices, which is only slightly trending downwards, is trending at an up-wards angle. This means that over the years the occupant loads for these five spaces has continued to increase over time. The results from our extensive study review can be seen within the five graphs while the results from our studies can be seen and studied in appendixes O, P, Q and R. The results from real estate agents were not included in these tables because they are inconclusive.

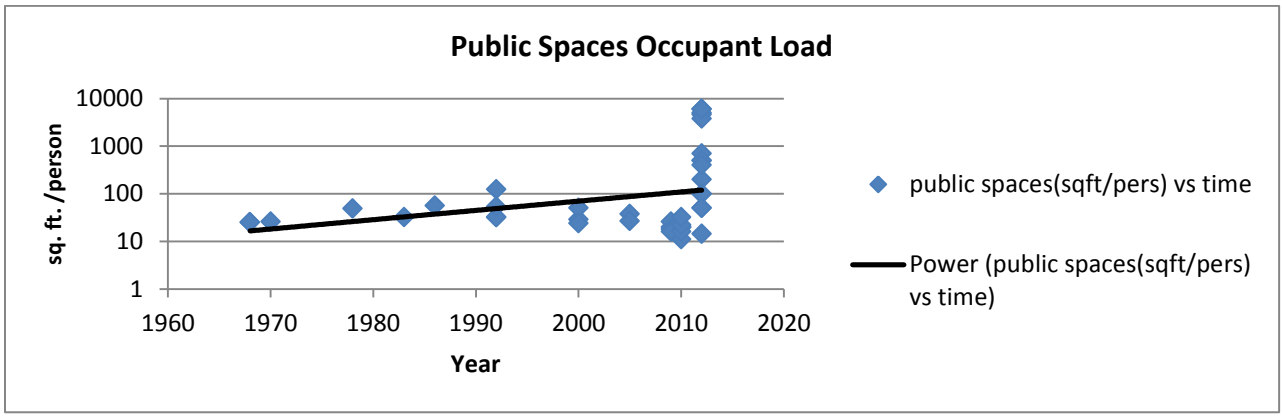


Figure 7: Public Spaces Occupant Load

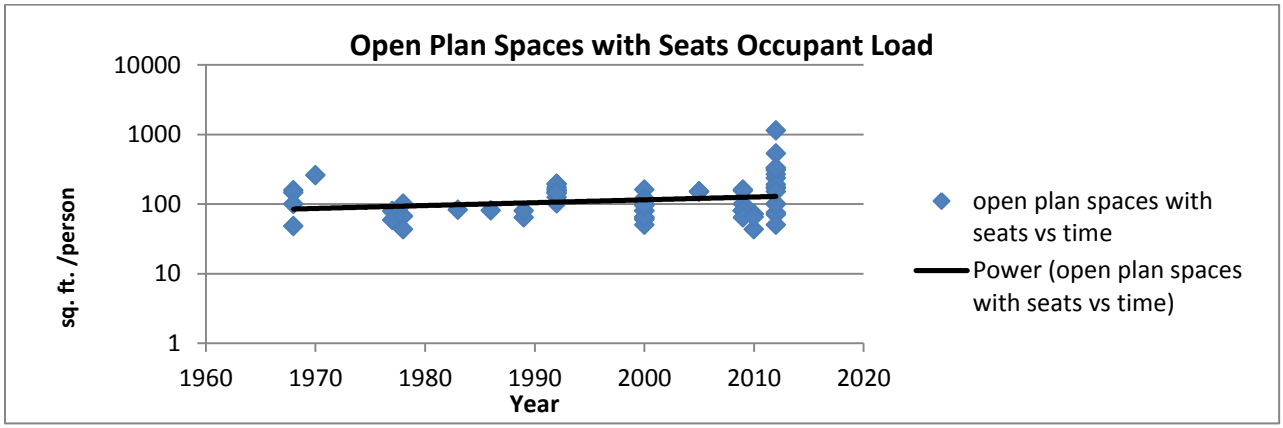


Figure 8: Open Spaces with Seats Occupant Load

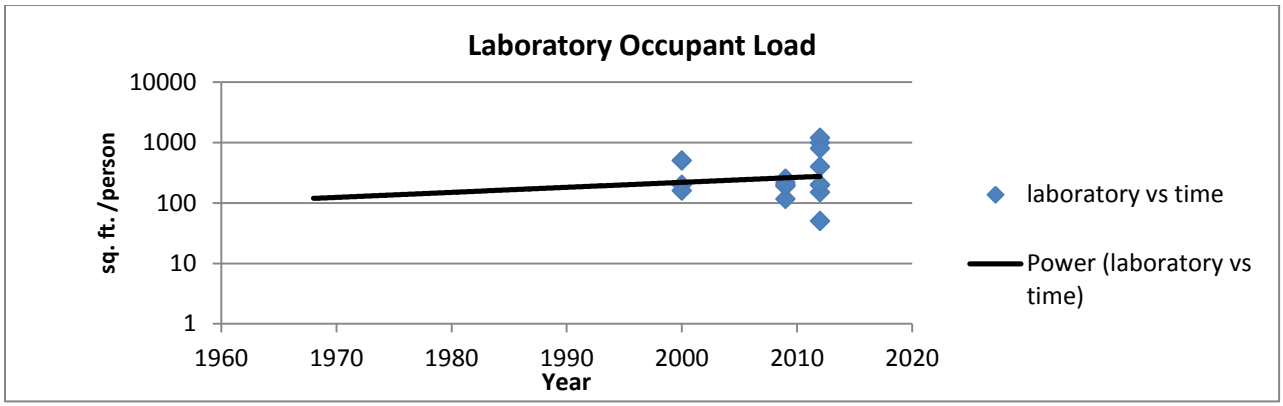


Figure 9: Laboratory Occupant Load

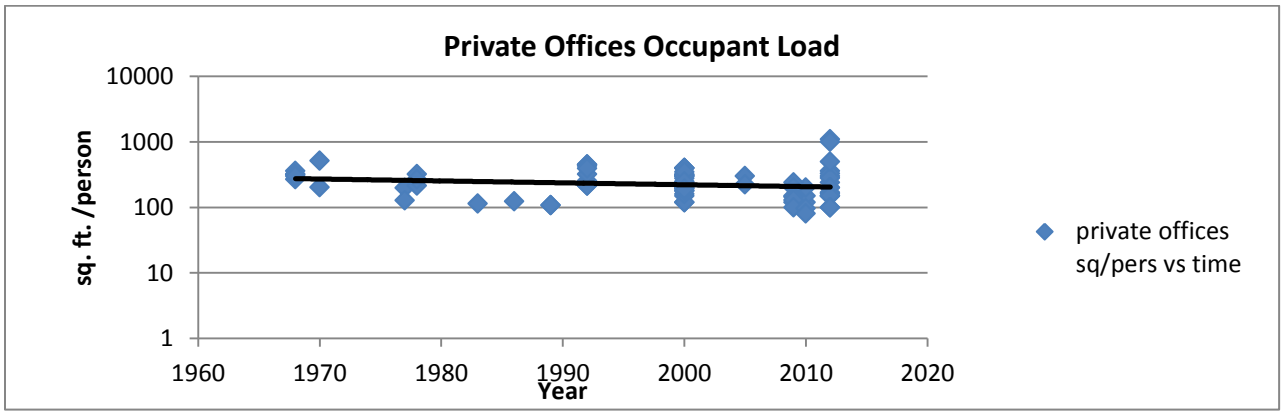


Figure 10: Private Offices Occupant Load

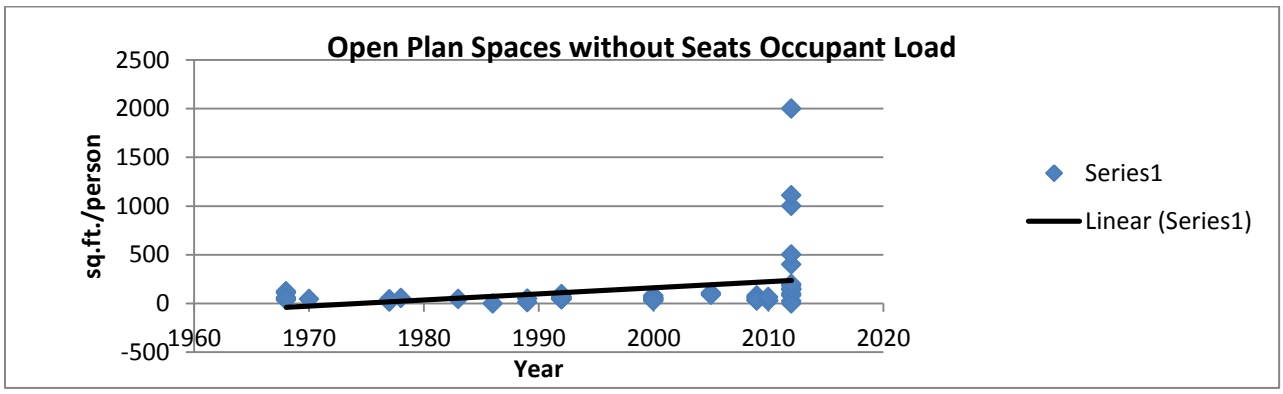


Figure 11: Open Plan Spaces without Seats Occupant Load

Our results span over 44 years from 1968 till 2012 and include 22 references as seen in the Appendix, not counting the 3 surveys that were sent out to Building Owners, Real-Estate People and Architects.

Discussion

From the results section, we can see that the occupant load factor for the five categories we selected, with the exception of private offices, appears to increase over time. Some of the values that we got were way over 100 square feet per person, the standard occupant load factor stated in NFPA 101.

The values we found for each category were very different, suggesting that it is appropriate to separate the business use occupancy load into the following categories:

- Private offices with closed floor to ceiling partitions
- Open plan spaces with seating with opened floor to ceiling partitions
- Open plan spaces with limited or no seating with or without semi partitions
- Laboratory function spaces either wet or dry type
- Public access spaces such as entrance lobbies, waiting areas, etc.

This was also suggested by the wide range of values concluded from past occupant load studies. Also our references presented in section 4.e. indicate that the trend for the occupant load factor is to go up in value.

Conclusion

We suggest that business use occupancy load should be separated into five categories with separate occupant loads for each category. Below, is the table of averages we found in previous for our five different categories and then below that is our suggested occupant load standard for each given category. The average occupant load for all these five categories combined is almost double the current occupant load at 196.10 square feet.

	Private offices with closed floor to ceiling partitions	Open plan spaces with seating with opened floor to ceiling partitions	Open plan spaces with limited or no seating with or without semi partitions	Laboratory function spaces either wet or dry type	Public access spaces such as entrance lobbies, waiting areas, etc.
sq. ft./person	258.68	143.68	147.24	364.56	66.35

- Private offices with closed floor to ceiling partitions (260 square feet)
- Open plan spaces with seating with opened floor to ceiling partitions (145 square feet)
- Open plan spaces with limited or no seating with or without semi partitions (150 square feet)
- Laboratory function spaces either wet or dry type (364 square feet)
- Public access spaces such as entrance lobbies, waiting areas, etc. (72 square feet)

As you can see in our table above, from the data we received and collected, these suggested occupant load standards for the different categories is a very reasonable conclusion. For each category we actually decided to use a more liberal number than was given for each respective category average because over the years businesses have been transitioning to much more open office plans. Also, as you can see in the Milke study, buildings from the early half of the 20th century actually skew the results to return a more conservative number than

what would be shown today. We figure that more liberal numbers will suit this transition of more and more open offices spaces moving forward.

In the case that our proposed categories are not accepted and instead one, singular business occupant load category is kept we suggest, from our research, that the business occupancy load should be significantly increased from the current 100 square feet. From our findings, we conclude that if only one occupant load encompasses the multiple different types of business uses than that this number should be doubled from 100 square feet to 200 square feet. We conclude that businesses are using open offices plans more often than ever before and this 200 square foot business occupant load would be increased significantly enough to satisfy an increase in open space plans in the near future.

Appendix A

Table 1. Office Building Measurements by Courtney, *et al.*

Building Number	Number of Stories	Floor #	Floor Area (ft^2)	Population on Typical Floor	Gross Area (ft^2/person)
3	33	31-33 23-30 18-22 3-17 1-2	2,500 3,800 6,460 17,700 21,600	142	120
4	21	all	6,900	52	132
5	20	all	8,800	64	137
6	19	all	7,200	100	72
7	17	all	20,000	300	66
9	12	all	6,960	46	151
10	12	all	6,300	92	68
11	11	all	4,850	48	100
12	11	all	8,000	100	80
13	10	all	4,000	25	160
14	9	all	4,700	50	94
17	2	all	8,000	60	133
18	2	all	9,500	70	135
Total			1,594,370	18,302	87.1

Note: This table is adapted from the 1996 James Milke Study.

Appendix B

"Fully" Closed Office

Description Tenant Occupiable Areas	Qty.	SF Each	Space Req'd.	Sum Actual SF	Tenant Usable Factor	Tenant USF
Office Spaces				12,170		
Enclosed Executive Offices	2	225	450			
Enclosed Large Offices	52	150	7,800			
Enclosed Small Offices	26	120	3,120			
Open Large Office	0	140	0			
Open Small Office	0	100	0			
Open Workstations	9	80	720			
Reception Desk	1	80	80			
Support Spaces				3,134		
Reception Seating	1	200	200			
"Unimproved" Conference Large	1	600	600			
Conference Small	3	150	450			
Informal Breakout Centers	0	80	0			
Printer/Copier/Fax Center	3	60	180			
Break Room Service Unit	1	340	340			
Information Reference Centers	2	150	300			
Supply Room	4	40	160			
Work Room	1	200	200			
File Area	2	144	288			
Documents Room	1	240	240			
Server Room	1	176	176			
Tenant Suite			15,304	15,304	1.35	20,592

Note: Adapted from the Whole Building Design Guide
http://www.wbdg.org/design/office_st.php

Appendix C

"Fully" Open Office

Description Tenant Occupiable Areas	Qty.	SF Each	Space Req'd.	Sum Actual SF	Tenant Usable Factor	Tenant USF
Office Spaces				10,600		
Enclosed Executive Offices	0	180	0			
Enclosed Large Offices	0	150	0			
Enclosed Small Offices	0	120	0			
Open Large Office	4	180	720			
Open Small Office	15	120	1,800			
Open Workstations	100	80	8,000			
Reception Desk	1	80	80			
Support Spaces	30%			4,614		
Reception Seating	1	120	120			
"Unimproved" Conference Large	1	600	600			
Conference Small	5	150	750			
Informal Breakout Centers	12	80	960			
Printer/Copier/Fax Center	3	80	240			
Break Room Service Unit	1	340	340			
Information Reference Centers	3	180	540			
Supply Center	4	40	160			
Work Center	1	200	200			
File Area	2	144	288			
Documents Room	1	240	240			
Server Room	1	176	176			
Tenant Suite			15,214	15,214	1.35	20,572

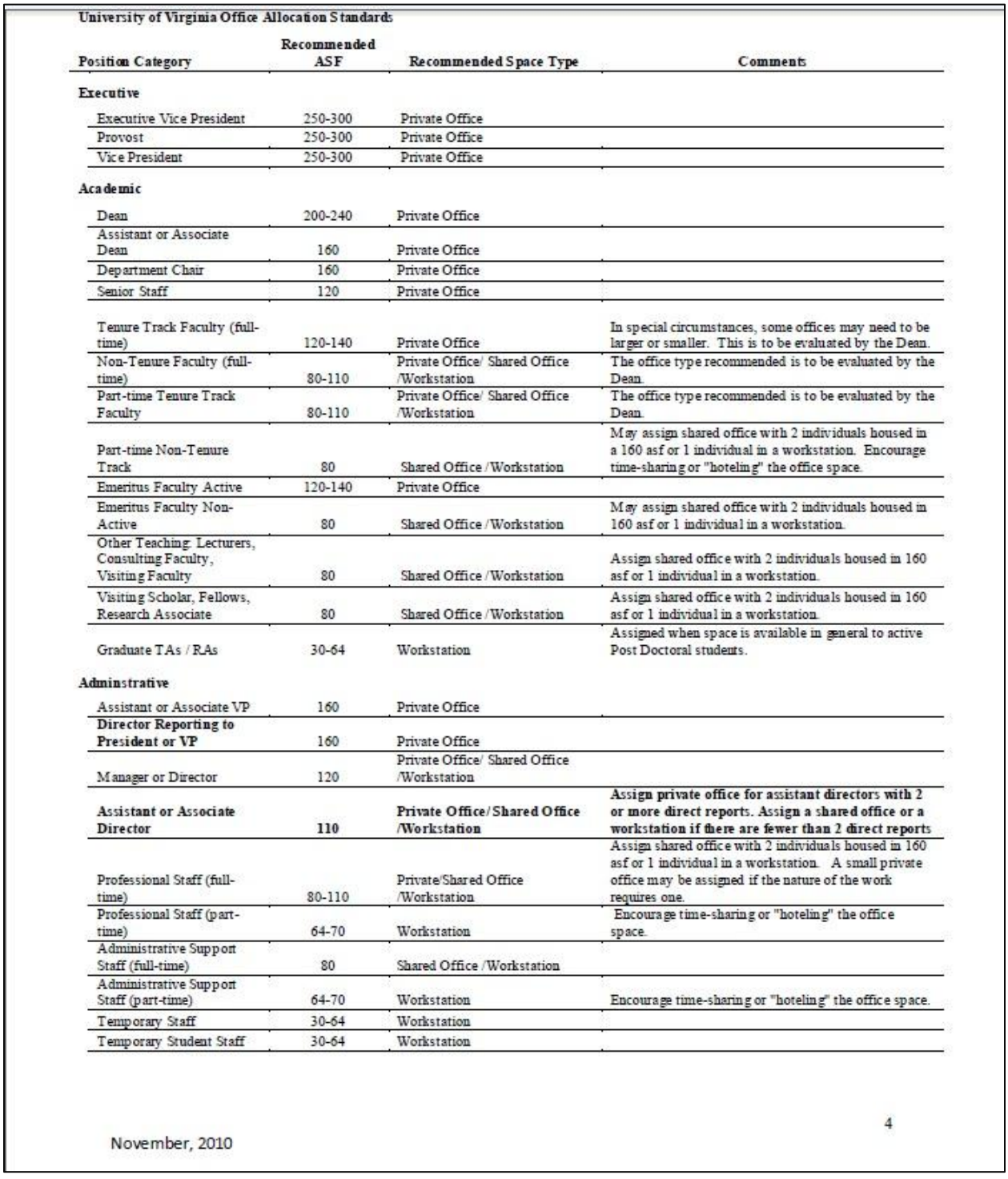
Note: Adapted from the Whole Building Design Guide
http://www.wbdg.org/design/office_st.php

Appendix D

Major CIP Groups*	Recommended ASF per Station Planning Guidelines	Range Low	Range High
Area Studies	35	35	40
Law	35	30	40
Letters	35	N/A	40
Library Science	35	30	40
Mathematics	35	30	40
Public Administration	35	35	40
Business	35	35	40
Foreign Languages	45	40	50
General Studies	45	40	50
Social Sciences	45	30	70
Education	50	35	150
Psychology	50	30	70
Natural Sciences	60	25	70
Communications	60	35	96
Computer Sciences	60	50	60
Agricultural Business	65	50	125
Biological Sciences	65	25	80
Health Professions	65	40	175
Home Economics	70	45	100
Agricultural Sciences	75	55	160
Architecture	75	60	85
Physical Sciences	80	40	90
Arts	90	50	175
Engineering	120	35	180

Note: Idaho State University Assignable Square Feet per Station Planning Guidelines
http://www.isu.edu/facilities/standards/Space-Standards.pdf

Appendix E



University of Virginia Office Allocation Standards

Position Category	Recommended ASF	Recommended Space Type	Comments
Executive			
Executive Vice President	250-300	Private Office	
Provost	250-300	Private Office	
Vice President	250-300	Private Office	
Academic			
Dean	200-240	Private Office	
Assistant or Associate Dean	160	Private Office	
Department Chair	160	Private Office	
Senior Staff	120	Private Office	
Tenure Track Faculty (full-time)	120-140	Private Office	In special circumstances, some offices may need to be larger or smaller. This is to be evaluated by the Dean.
Non-Tenure Faculty (full-time)	80-110	Private Office/ Shared Office /Workstation	The office type recommended is to be evaluated by the Dean.
Part-time Tenure Track Faculty	80-110	Private Office/ Shared Office /Workstation	The office type recommended is to be evaluated by the Dean.
Part-time Non-Tenure Track	80	Shared Office /Workstation	May assign shared office with 2 individuals housed in a 160 asf or 1 individual in a workstation. Encourage time-sharing or "hoteling" the office space.
Emeritus Faculty Active	120-140	Private Office	
Emeritus Faculty Non-Active	80	Shared Office /Workstation	May assign shared office with 2 individuals housed in 160 asf or 1 individual in a workstation.
Other Teaching: Lecturers, Consulting Faculty, Visiting Faculty	80	Shared Office /Workstation	Assign shared office with 2 individuals housed in 160 asf or 1 individual in a workstation.
Visiting Scholar, Fellows, Research Associate	80	Shared Office /Workstation	Assign shared office with 2 individuals housed in 160 asf or 1 individual in a workstation.
Graduate TAs / RAs	30-64	Workstation	Assigned when space is available in general to active Post Doctoral students.
Administrative			
Assistant or Associate VP	160	Private Office	
Director Reporting to President or VP	160	Private Office	
Manager or Director	120	Private Office/ Shared Office /Workstation	
Assistant or Associate Director	**110**	**Private Office/ Shared Office /Workstation**	**Assign private office for assistant directors with 2 or more direct reports. Assign a shared office or a workstation if there are fewer than 2 direct reports**
Professional Staff (full-time)	80-110	Private/Shared Office /Workstation	Assign shared office with 2 individuals housed in 160 asf or 1 individual in a workstation. A small private office may be assigned if the nature of the work requires one.
Professional Staff (part-time)	64-70	Workstation	Encourage time-sharing or "hoteling" the office space.
Administrative Support Staff (full-time)	80	Shared Office /Workstation	
Administrative Support Staff (part-time)	64-70	Workstation	Encourage time-sharing or "hoteling" the office space.
Temporary Staff	30-64	Workstation	
Temporary Student Staff	30-64	Workstation	

4

November, 2010

Figure 1: UVA Allocation Standards
Note: This figure was adapted from the University of Virginia (November 2010)
http://www.web.virginia.edu/SREM/Space/UVA%20Office%20Space%20Allocation%20Guidelines_Nov%202010CompleteFinal.pdf

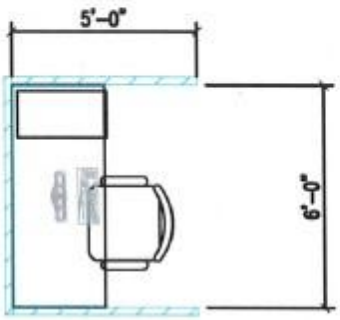
Appendix F

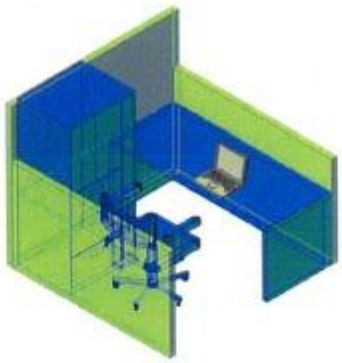
APPENDIX C EXAMPLES OF WORKSTATIONS

SMALL WORKSTATION
30.0 SQ. FT. USABLE

OPTIONS:

FILING :	24"
UPPER STORAGE:	72"
WORKSURFACE:	6'





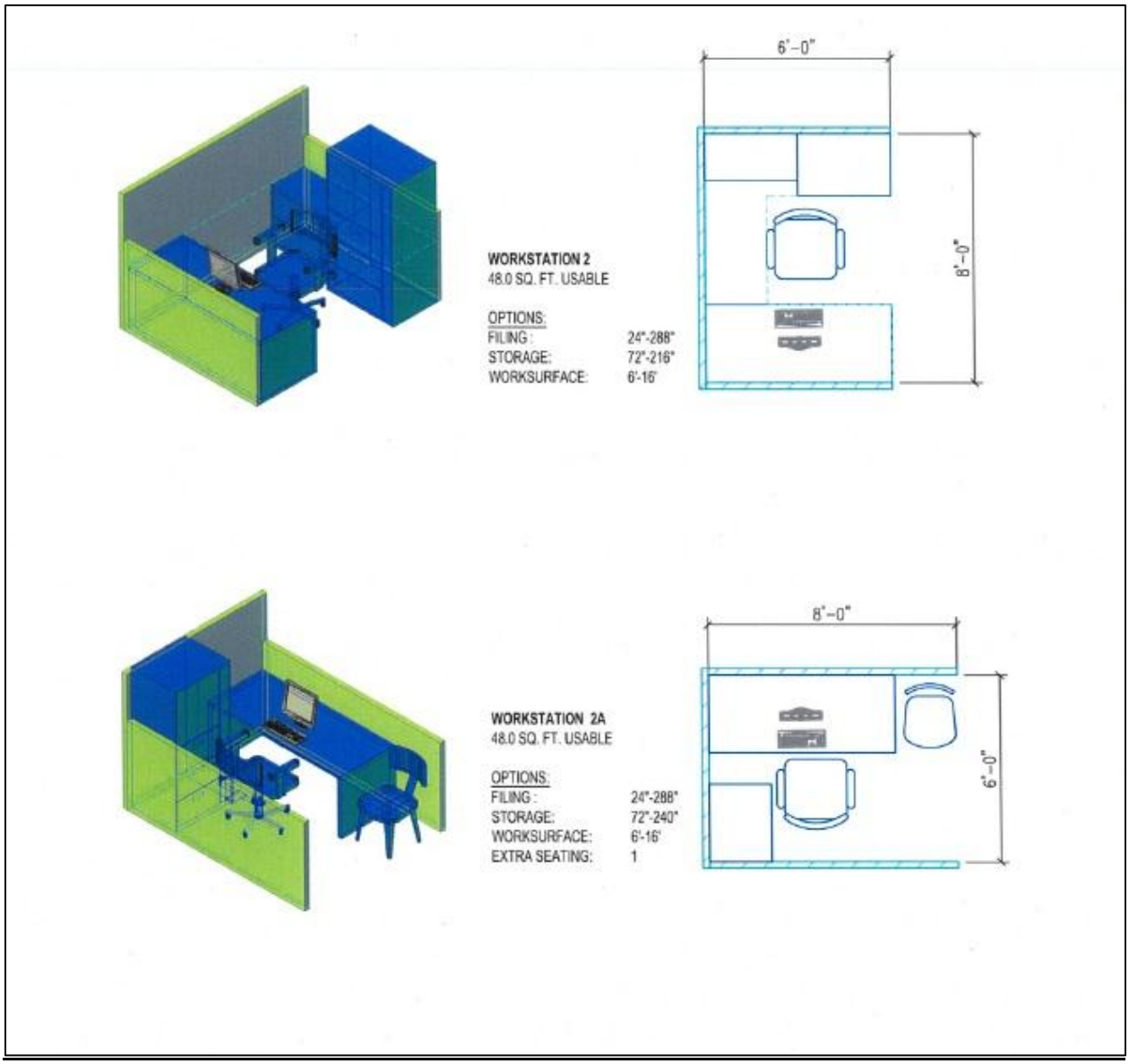
WORKSTATION 1
36.0 SQ. FT. USABLE

OPTIONS:

FILING :	24"-192"
STORAGE:	72"-192"
WORKSURFACE:	6'-10'

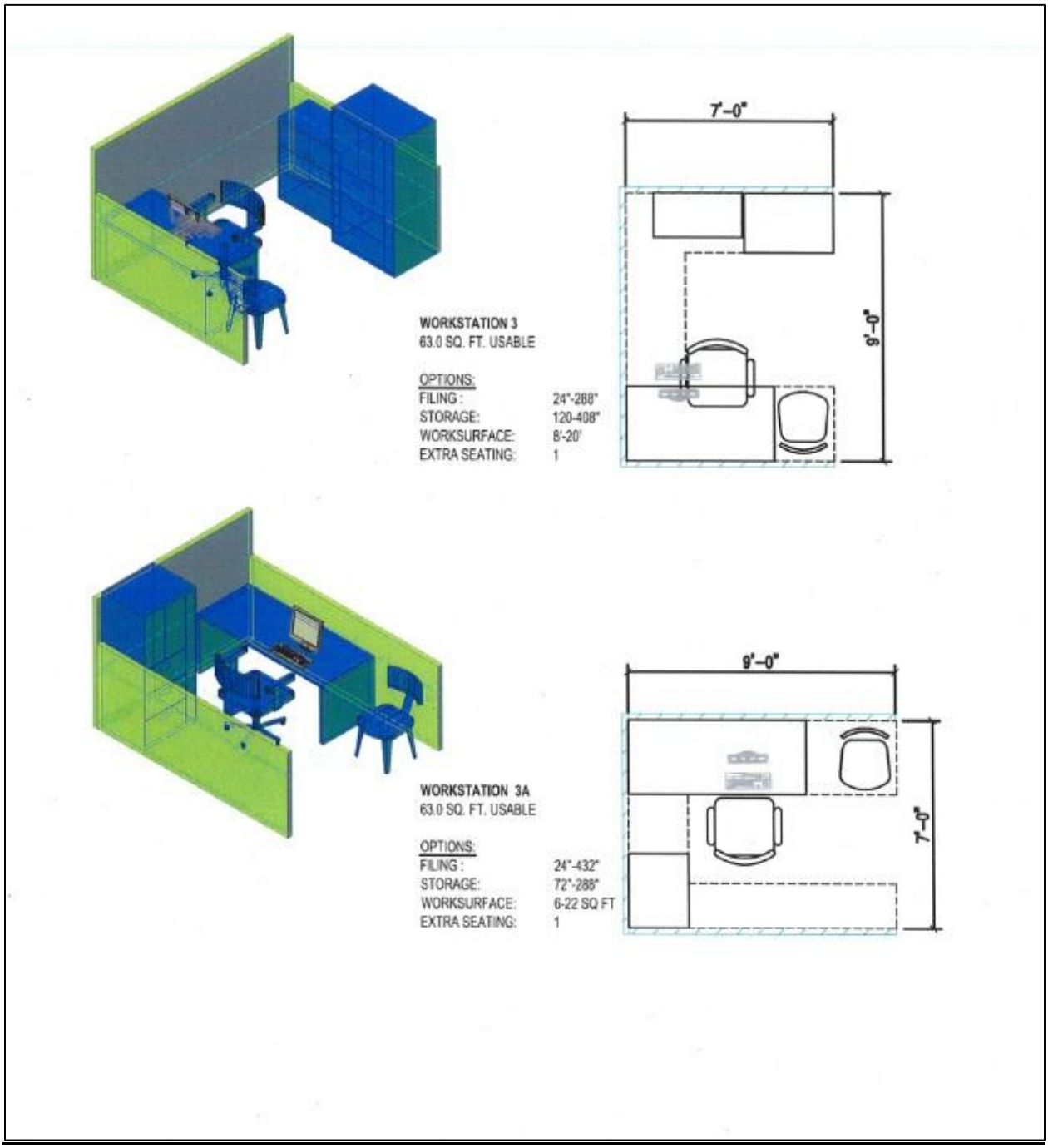
Note: This figure was adapted from the State of Washington's General Administration
http://www.ga.wa.gov/res/forms/SpaceAllocation.pdf

Appendix G



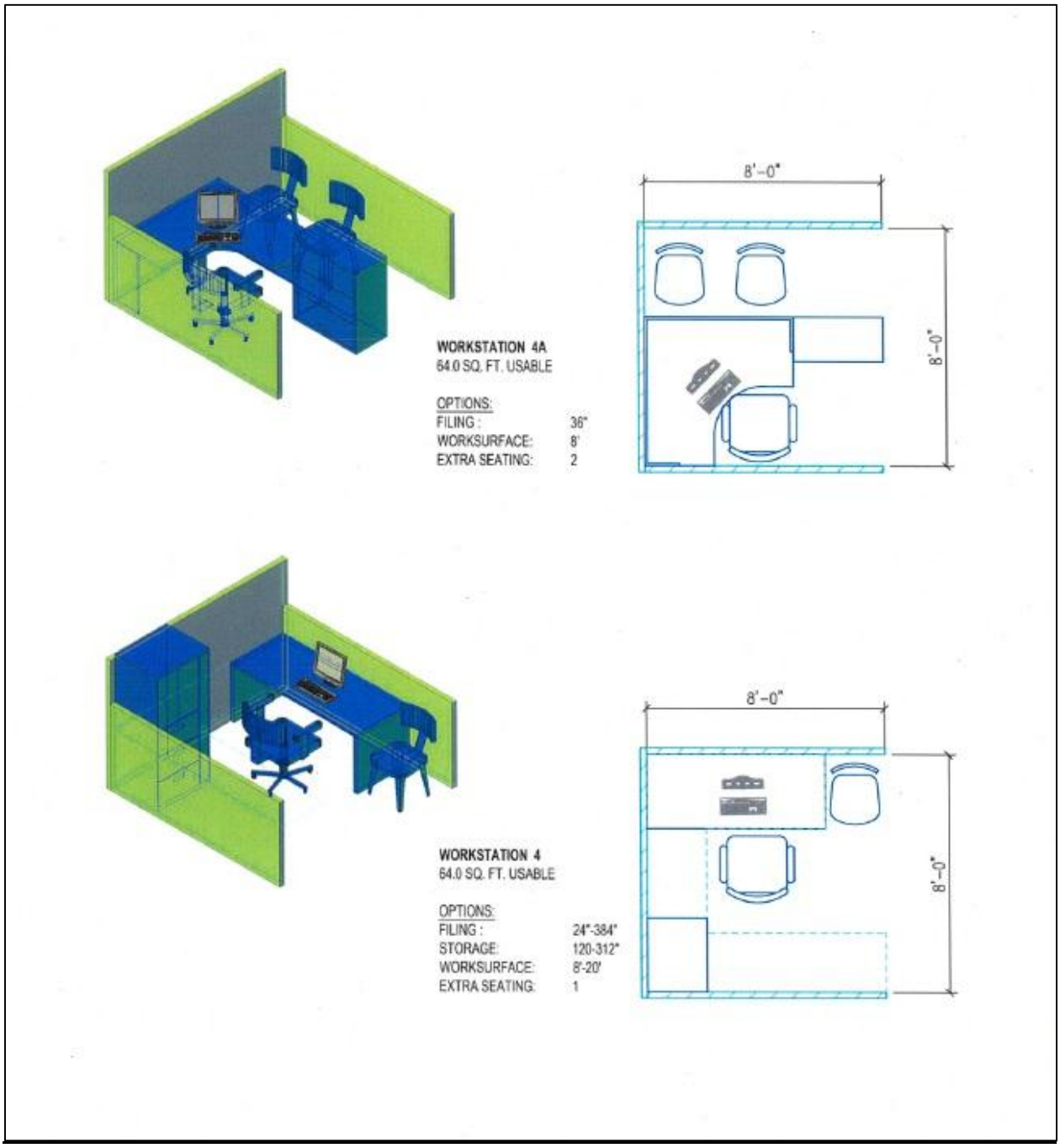
Note: This figure was adapted from the State of Washignton's General Administration
http://www.ga.wa.gov/res/forms/SpaceAllocation.pdf

Appendix H



Note: This figure was adapted from the State of Washington's General Administration
http://www.ga.wa.gov/res/forms/SpaceAllocation.pdf

Appendix I



Note: This figure was adapted from the State of Washignton's General Administration
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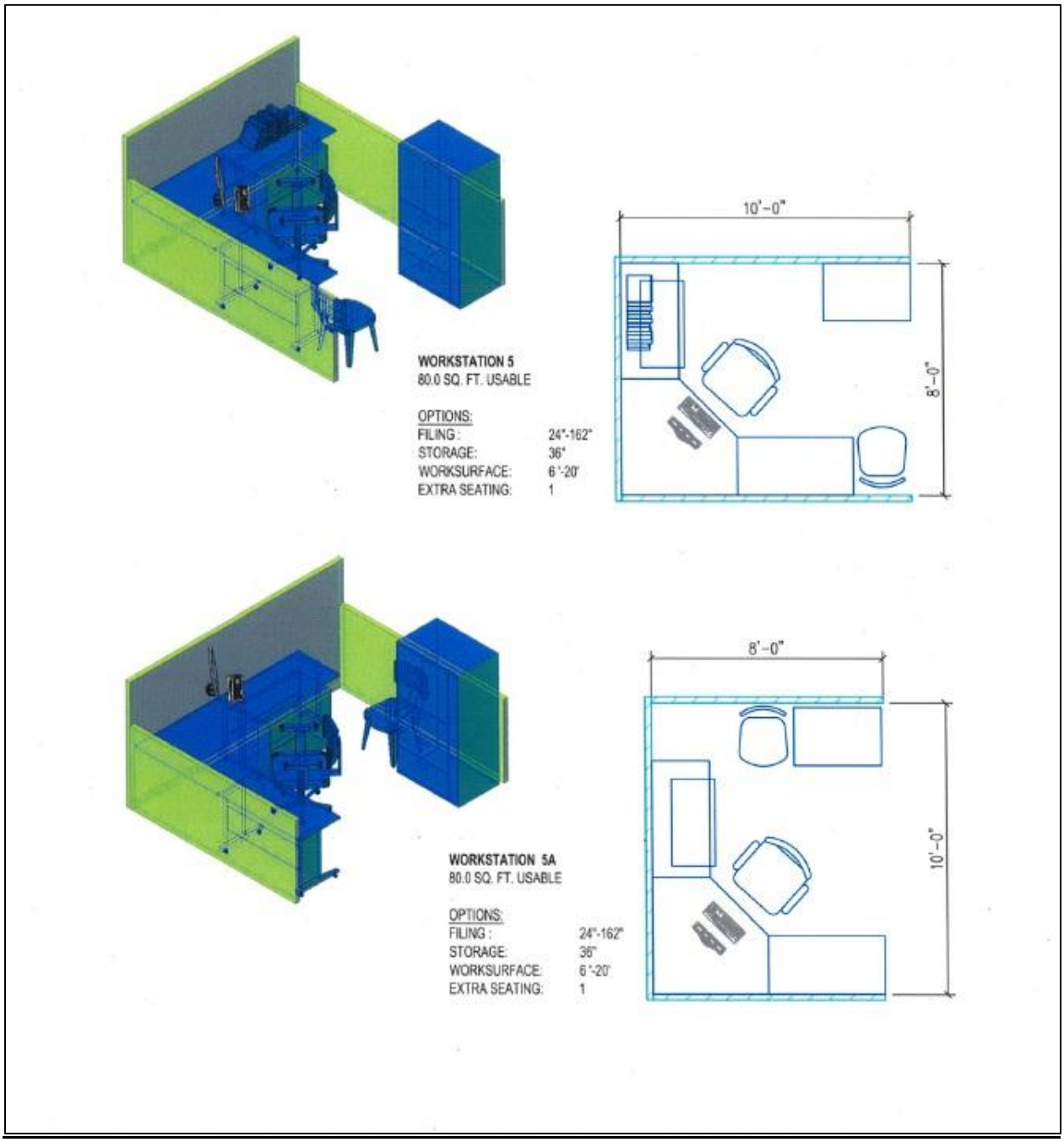
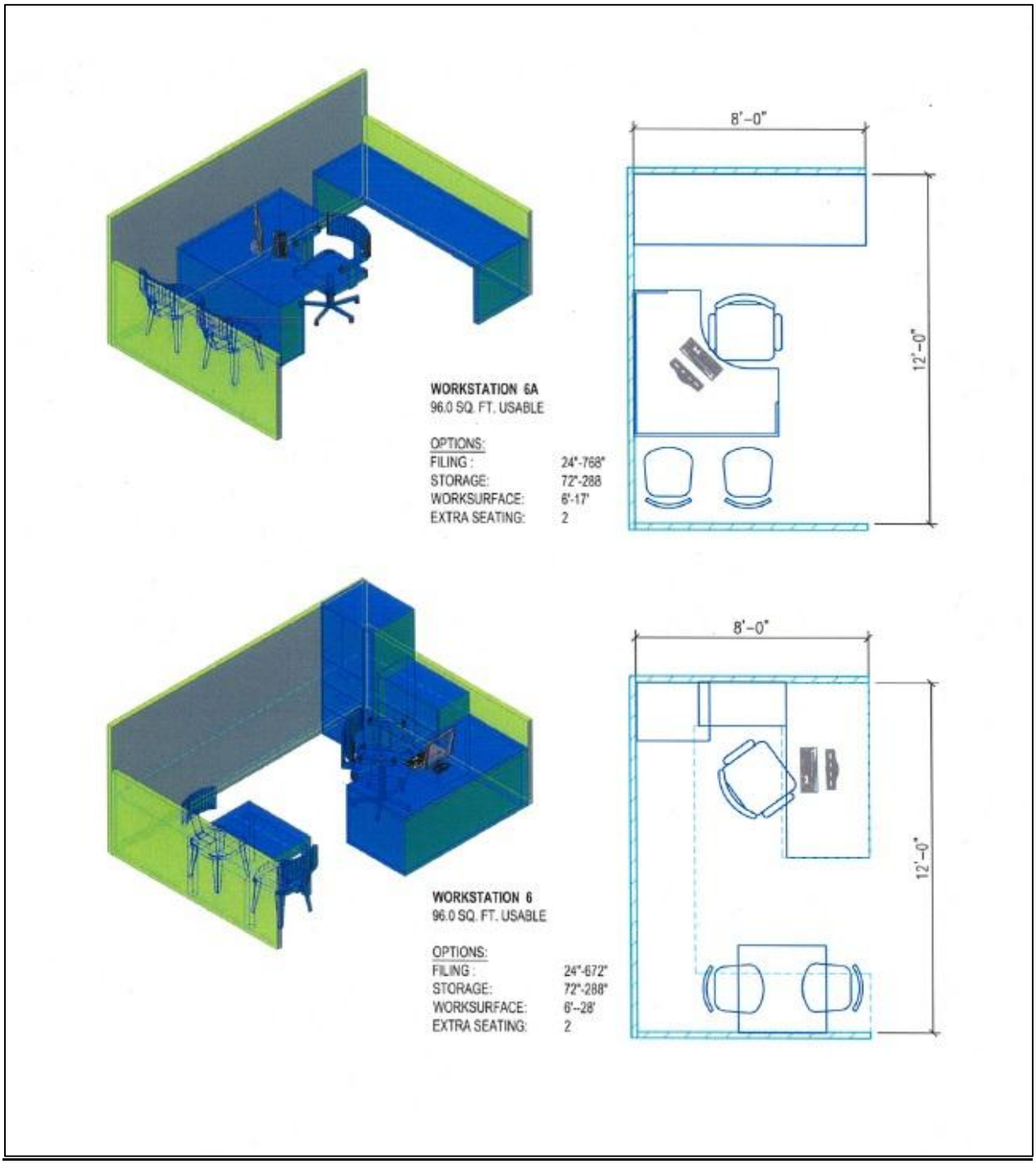
Appendix J



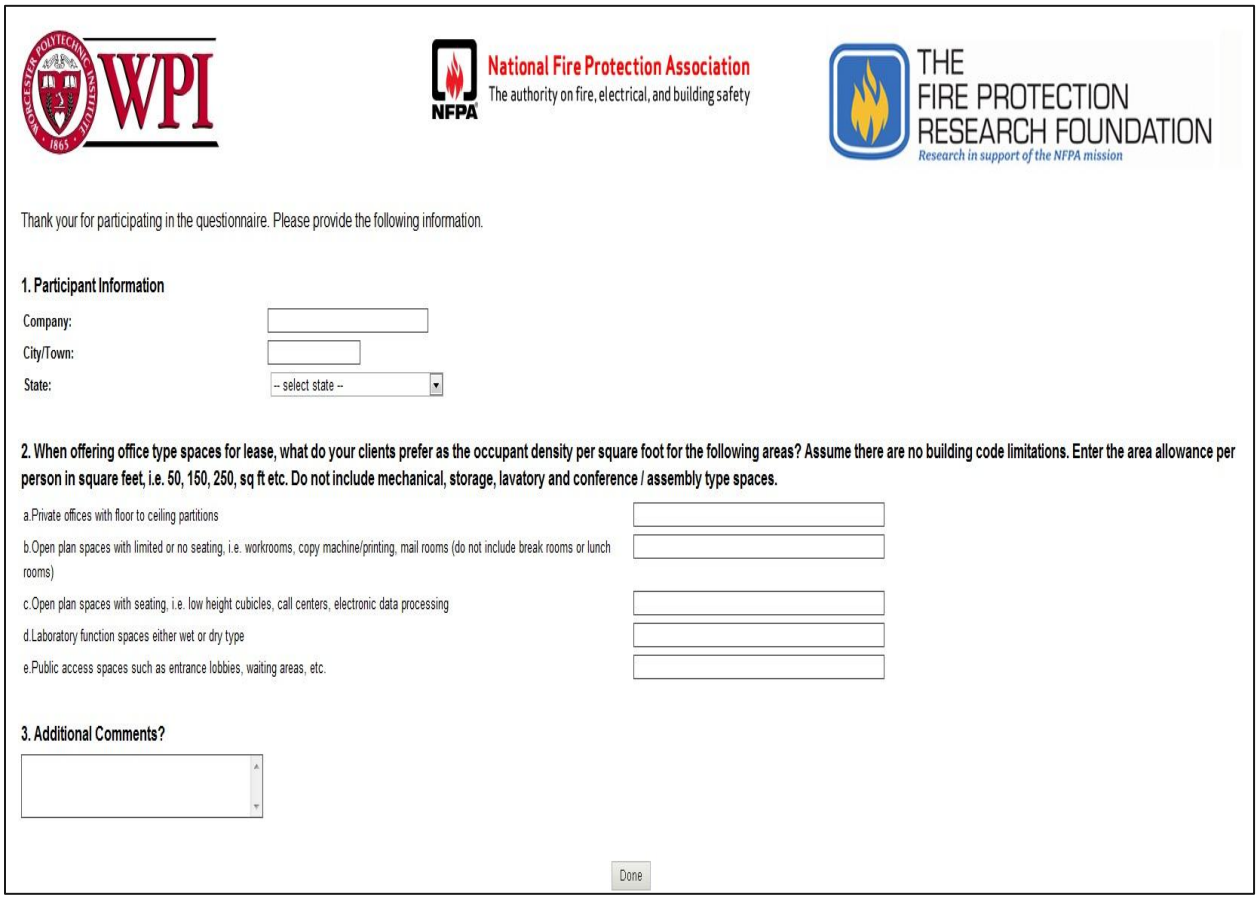
Note: This figure was adapted from the State of Washington's General Administration
http://www.ga.wa.gov/res/forms/SpaceAllocation.pdf

Appendix K



Note: This figure was adapted from the State of Washington's General Administration
http://www.ga.wa.gov/res/forms/SpaceAllocation.pdf

Appendix L



National Fire Protection Association
The authority on fire, electrical, and building safety

THE FIRE PROTECTION RESEARCH FOUNDATION
Research in support of the NFPA mission

Thank your for participating in the questionnaire. Please provide the following information.

1. Participant Information

Company:

City/Town:

State: -- select state --

2. When offering office type spaces for lease, what do your clients prefer as the occupant density per square foot for the following areas? Assume there are no building code limitations. Enter the area allowance per person in square feet, i.e. 50, 150, 250, sq ft etc. Do not include mechanical, storage, lavatory and conference / assembly type spaces.

a. Private offices with floor to ceiling partitions

b. Open plan spaces with limited or no seating, i.e. workrooms, copy machine/printing, mail rooms (do not include break rooms or lunch rooms)

c. Open plan spaces with seating, i.e. low height cubicles, call centers, electronic data processing

d. Laboratory function spaces either wet or dry type

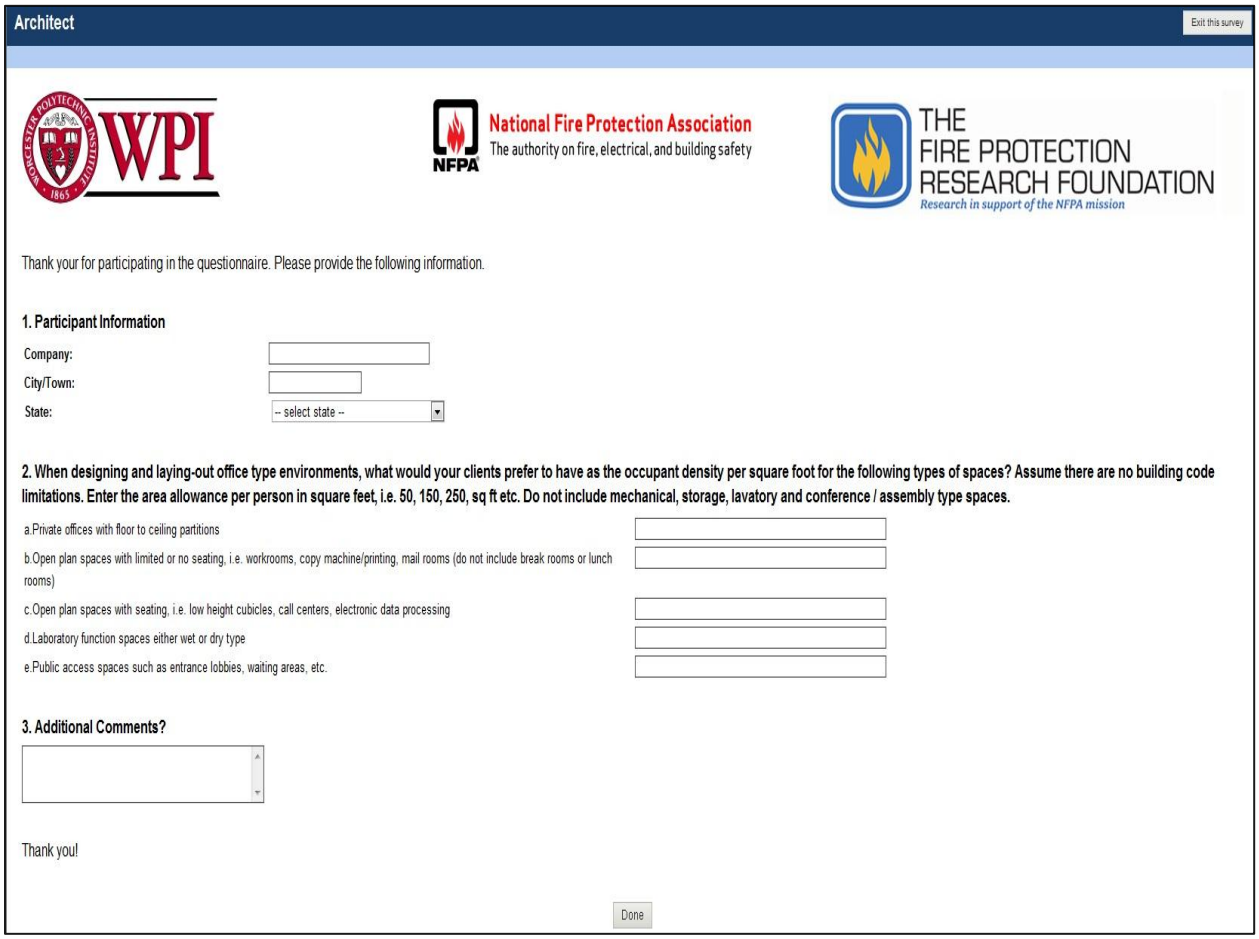
e. Public access spaces such as entrance lobbies, waiting areas, etc.

3. Additional Comments?

Done

Note: Real Estate Survey presented by our IQP team
http://www.surveymonkey.com/s/HL8M2YG

Appendix M



Architect

Exit this survey

National Fire Protection Association
The authority on fire, electrical, and building safety

THE FIRE PROTECTION RESEARCH FOUNDATION
Research in support of the NFPA mission

Thank your for participating in the questionnaire. Please provide the following information.

1. Participant Information

Company:

City/Town:

State: -- select state --

2. When designing and laying-out office type environments, what would your clients prefer to have as the occupant density per square foot for the following types of spaces? Assume there are no building code limitations. Enter the area allowance per person in square feet, i.e. 50, 150, 250, sq ft etc. Do not include mechanical, storage, lavatory and conference / assembly type spaces.

a.Private offices with floor to ceiling partitions

b.Open plan spaces with limited or no seating, i.e. workrooms, copy machine/printing, mail rooms (do not include break rooms or lunch rooms)

c.Open plan spaces with seating, i.e. low height cubicles, call centers, electronic data processing

d.Laboratory function spaces either wet or dry type

e.Public access spaces such as entrance lobbies, waiting areas, etc.

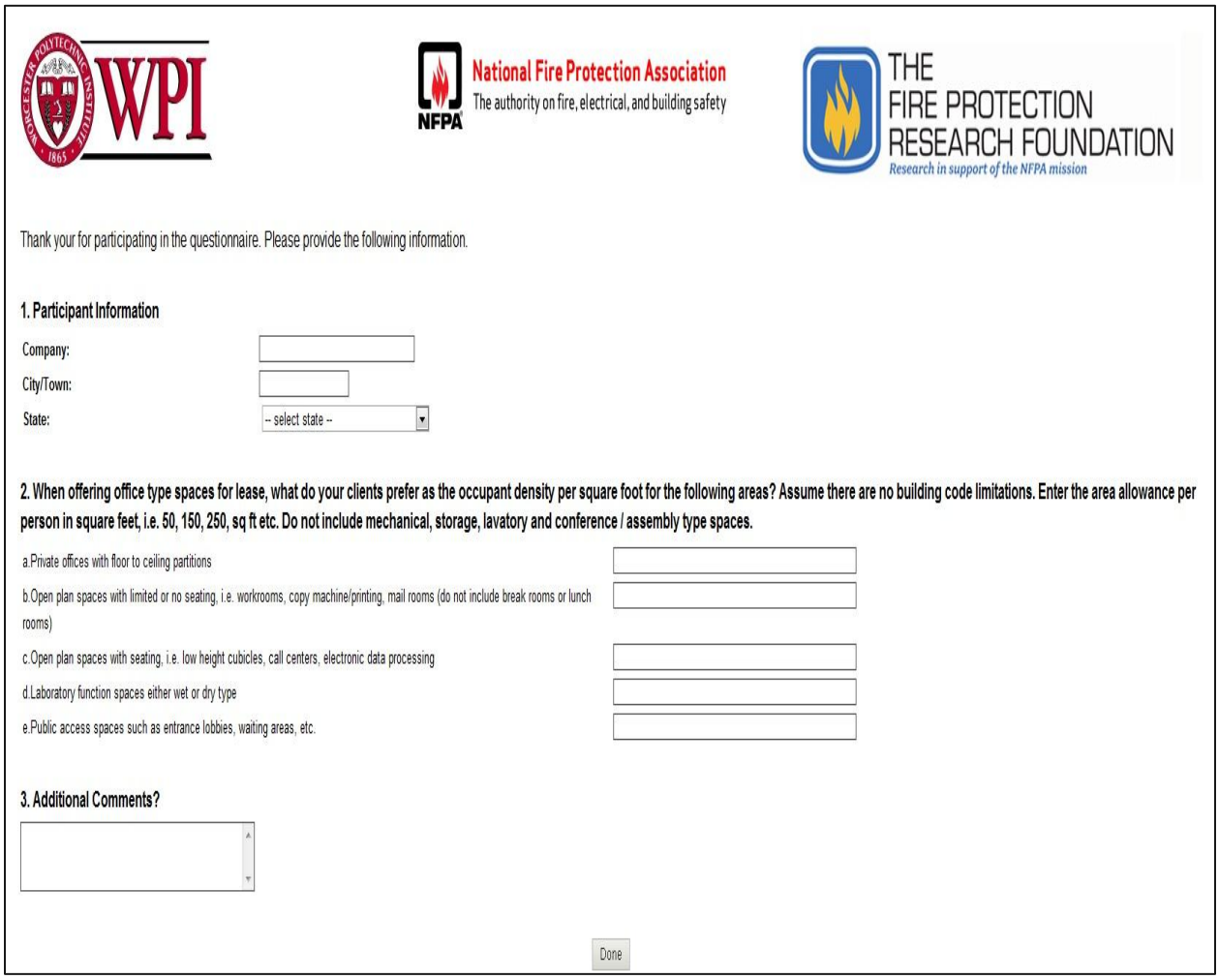
3. Additional Comments?

Thank you!

Done

Note: Architect Survey presented by our IQP team
http://www.surveymonkey.com/s/HKXK2Y5

Appendix N



National Fire Protection Association
The authority on fire, electrical, and building safety

THE FIRE PROTECTION RESEARCH FOUNDATION
Research in support of the NFPA mission

Thank your for participating in the questionnaire. Please provide the following information.

1. Participant Information

Company:

City/Town:

State: -- select state --

2. When offering office type spaces for lease, what do your clients prefer as the occupant density per square foot for the following areas? Assume there are no building code limitations. Enter the area allowance per person in square feet, i.e. 50, 150, 250, sq ft etc. Do not include mechanical, storage, lavatory and conference / assembly type spaces.

a. Private offices with floor to ceiling partitions

b. Open plan spaces with limited or no seating, i.e. workrooms, copy machine/printing, mail rooms (do not include break rooms or lunch rooms)

c. Open plan spaces with seating, i.e. low height cubicles, call centers, electronic data processing

d. Laboratory function spaces either wet or dry type

e. Public access spaces such as entrance lobbies, waiting areas, etc.

3. Additional Comments?

Done

Note: Building Owner Survey presented by our IQP team
http://www.surveymonkey.com/s/H8C22YP

Appendix O

Architects			Building owners		
Private offices with floor to ceiling partitions			Private offices with floor to ceiling partitions		
people	sqft	sqft/person	people	sqft	sqft/person
		150	400	120000	300
		200	65	11000	169.2307692
		200	64	70000	1093.75
		150	25	9000	360
		150	500	165000	330
		100	250	60000	240
		100	791	222020	280.6826802
			15	15000	1000
			400	65000	162.5
			250	125460	501.84

Note: This tabled is derived from our questionnaires we sent out to architects and building owners.

Appendix P

Architects			Building owners		
Open plan spaces with limited or no seating, i.e. workrooms, copy machine/printing, mail rooms (do not include break rooms or lunch rooms)			Open plan spaces with limited or no seating, i.e. workrooms, copy machine/printing, mail rooms (do not include break rooms or lunch rooms)		
people	sqft	sqft/person	people	sqft	sqft/person
		100	25	10000	400
		25	250	35000	140
		150	20	40000	2000
		80	6	6000	1000
		0	20	10000	500
		150	1100	200000	181.82
		200	30	33303	1110.1
				75000	
				5000	

Note: This tabled is derived from our questionnaires we sent out to architects and building owners.

Appendix Q

Architects			Building owners		
Open plan spaces with seating, i.e. low height cubicles, call centers, electronic data processing			Open plan spaces with seating, i.e. low height cubicles, call centers, electronic data processing		
people	sqft	sqft/person	people	sqft	sqft/person
		75	800	140000	175
		70	35	40000	1142.85714
		100	900	150000	166.666667
		100	15	8000	533.333333
		100	500	165000	330
		50	850	200000	235.294118
		150	3130	831780	265.744409
			850	260000	305.882353
			2900	550000	189.655172
			750	243540	324.72

Note: This tabled is derived from our questionnaires we sent out to architects and building owners.

Appendix R

Architects			Building owners		
Laboratory function spaces either wet or dry type			Laboratory function spaces either wet or dry type		
people	sqft	sqft/person	people	sqft	sqft/person
		400	5	5000	1000
		200	0	1000	
		800	25	30000	1200
		150			
		200			
		50			

Architects			Building owners		
Public access spaces such as entrance lobbies, waiting areas, etc.			Public access spaces such as entrance lobbies, waiting areas, etc.		
people	sqft	sqft/person	people	sqft	sqft/person
		200	10	5000	500
			0	17000	
		50	5	25000	5000
		400	2	1400	700
		100	10	60000	6000
		100	1400	20000	14.28571
		50	5	23000	4600
			2	7500	3750
			25	150000	6000
			2	1000	500

Note: This tabled is derived from our questionnaires we sent out to architects and building owners.

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